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THE HISTORICAL AND PHYSICAL GEOGRAPHY OF THE  
DEAD SEA REGION.

AN ADDRESS BY THE  
REV. PUTNAM CADY.

The Dead Sea is the most mysterious body of water on the globe, and the region around it is physically the most remarkable in the world. Although the sea is only twenty miles from Jerusalem, and almost in the heart of a country historically famous for more than five thousand years, yet it has never been thoroughly explored, and many parts of the mountains along the eastern shore are *terra incognita*.

In the Talmud the lake is called The Sea of Sodom. The Bible calls it The Salt or East Sea. Josephus gives its name as Asphaltic Lake; and by Jerome it is called The Dead Sea. By the Arabs, however, it is named Bahr Lût ("Sea of Lot"). It will be noticed that several of these names associate it with the destruction of the Cities of the Plain. When the explorer realizes that this is the lowest spot on the surface of the earth, and experiences the intense heat as the sun pours his burning rays down into this gulf, he will appreciate the words of Professor George Adam Smith when he says: "In this awful hollow, this bit of the infernal regions come up to the surface, this hell with the sun shining into it, primitive man laid the scene of God's most terrible judgment on human sin. The glare of Sodom and Gomorrah is flung down the whole length of Scripture history."

The approaches to the Sea are in keeping with its character, and prepare one for the wild and lonely shore to be visited. The way by Bethlehem and Engedi leads through the barren wilderness in which David hid from Saul. Ever since that time it has been a place of refuge for outlaws and wandering Bedouin. Winding wadies that are dry and hot, save when heavy storms in the rainy

season send torrents rushing down for a few hours, stretch out in all directions. The approach by either Mar Saba down the Wady en-Nâr ("Valley of Fire"), or by Bethany and the Wady Kelt, is very much of the same character. It has been aptly described as "twenty miles of chaos." At many places on the road along the Wady Kelt a few steps will take the traveller to the edge of a cliff down which he may look hundreds of feet to the stream below.

Perhaps the best description of the physical surroundings of this mysterious sea is given by Professor George Adam Smith in his *Historical Geography of the Holy Land*. "No one can live in Judea," he says, "without being daily aware of an awful deep which bounds it on the east—the lower Jordan Valley and the Dead Sea. From Bethel, from Jerusalem, from Bethlehem, from Tekoa, from the heights above Hebron, and from fifty points between, you look down into that deep, and you feel Judea rising from it about you almost as a sailor feels his narrow deck or a sentinel the sharp-edged platform of his high fortress. From the hard limestone of the range on which you stand the land sinks swiftly through softer formations, desert and chaotic, to a depth of which you cannot see the bottom—but you know that it falls far below the level of the ocean—to the coasts of a bitter sea. Across this emptiness rise the hills of Moab, high and precipitous; and it is their bare edge, almost unbroken and with nothing visible beyond, which forms the eastern horizon of Judea. The depth, the singularity of that gulf and its prisoned sea, the high barrier beyond, conspire to produce on the inhabitants of Judea a moral effect such as is created by no other frontier in the world."

The eastern shore of the Sea is different in many respects from the western. The mountains rise precipitously to a height of from two thousand five hundred to more than three thousand feet. But back of this range is the fertile tableland of Moab, fifty miles long and twenty wide. With this nothing along the western shore can compare. Ruins of towns are scattered all over the country, and give evidence of a vast population in past centuries.

This section is of great interest to the archæologist and the historian. While it is not really in line with the topic assigned me, I feel that I must call your attention to one point of interest. On the very border of Moab—almost on the edge of the great Arabian desert—stands a remarkable ruin. It is a palace five hundred and seventy feet square, having an immense paved court. It has in part been photographed several times; but, as perhaps, not over twenty Europeans have seen it, its beauty is not well known. It was discov-

ered in 1872 by Canon Tristram, and some account of it may be found in his book on *The Land of Moab*. Merrill also speaks of it in his volume *East of the Jordan*. This ruin, which is called Mashita, or Mashetta, gives us the finest work in art to be found in all that country, and can scarcely be surpassed by anything of the kind in the world. The whole front is decorated with magnificent and delicately-sculptured representations of animals, fruits, flowers, vines, and leaves. Immense rose-bosses break the surface and emphasize with light and shade the beauty of the front.

Who the builder was is not definitely settled. Many suppose that Chosroes of Persia, whose armies swept over this country about 614 A. D., erected it. Others believe that an early Christian emperor or some mighty Mohammedan prince built it. A somewhat fanciful story of its construction is given in *Harper's Monthly* for June, 1901. I have recently learned that the Sultan has presented this palace to Emperor William of Germany. Without doubt the Emperor will leave it where it is.

Having some idea of the surroundings of the Dead Sea, we now proceed to explore its surface. Not a solitary dwelling is on its coasts, and there is no living thing in its waters. As we stand on the north shore, the Sea stretches out some forty-two miles toward the south, and is, on an average, eight miles wide. The water is of a greenish-blue, and as clear as crystal. A soft haze covers the mountains of Moab on the east, and the Judean hills on the west loom up dark and desolate in their grandeur. Jerusalem is only twenty miles away, but it is three thousand eight hundred feet above us. Far to the west roll the blue waves of the Mediterranean, but they are one thousand three hundred feet higher than the spot on which we stand.

Either on this plain or on the one at the south end of the Sea once stood the cities that were overthrown by the fire of the Lord. Professor George Adam Smith is inclined to believe that the south end of the Sea is the place where the doomed cities were. Canon Tristram and Dr. Merrill would place them at the north end. Many mounds on the plains of Shittim, at the northeast end of the Sea, await the spade of the excavator. Possibly they may throw light upon the question. It would seem, however, that there is no reason for believing the cities to be beneath the waters of the Dead Sea. The Bible nowhere makes the statement that they were thus overthrown. Fire and brimstone rained down upon them, and they were overwhelmed. Lot stood at a point near Bethel, and saw all the plain, that it was well watered, and chose it because of its fertility.

This he might do if the plain were at the north end of the Sea. He could hardly make this observation if it were at the south end, more than fifty miles away. This, and the fact that Chedorlaomer swept past Hazazon-Tamar or Engedi before he attacked the cities, indicates that our supposition is probably correct. However, the final word cannot be said until the Turkish or some other Government allows full investigations to be made.

I have said that this whole region is physically the most remarkable in the world. Perhaps a few facts about the whole Jordan Valley may give us a better appreciation of our situation as we sail out upon this strange body of water.

Mount Hermon, far to the north, is about nine thousand feet high. One of the sources of the Jordan rises on its western slope ten hundred and fifty feet above sea-level. This joins others near the site of ancient Dan, and together they flow twelve miles until they enter the Waters of Merom or Lake Huleh, which is only six feet above the level of the Mediterranean. Passing through Lake Huleh, the Jordan hastens eleven miles down to the Sea of Galilee, which is six hundred and eighty feet below the level of the Mediterranean. From Galilee to the Dead Sea the distance is about sixty-five miles in a straight line; but the river is so crooked that it meanders over nearly two hundred miles before it empties into the Dead Sea where it is, as I have indicated, thirteen hundred feet below sea-level. There can, of course, be no outlet for the Dead Sea, and the volume of from six to ten million tons of water that the Jordan throws into it every twenty-four hours must be carried away by evaporation.

Under these conditions it may be readily imagined that exploring the Dead Sea is no easy task. Costigan was the first in modern times to make the attempt, and he lost his life under the burning rays of that fierce sun as they poured down into this "bit of the infernal regions brought up to the surface." Molyneux did not proceed far in his boat before a storm overtook him, and he died of exhaustion and fever. In 1847 our Government sent out an expedition under Lieut. Lynch, who spent twenty-two days on the Sea, and has given us nearly all that we know of its shore-line and various depths. Lynch also faced the dangers met by previous explorers, and on several occasions his expedition nearly came to an untimely end. He describes the storm that met him as he emerged from the mouth of the Jordan as being the fiercest he had ever faced. The metal plates of one of his boats were bent by the force of the waves. It was like a bombardment of waves of lead.

Some idea of their weight may be gained from the fact that while ordinary sea water contains from 4 to 6 per cent. of solid matter, the Dead Sea water has from 24 to 26 per cent. Possibly Lieut. Lynch's own words may be of interest: "At times it seemed as if the Dread Almighty frowned upon our efforts to navigate a sea the creation of His wrath. There is a tradition among the Arabs that no one can venture upon this sea and live. Repeatedly the fates of Costigan and Molyneaux had been cited to deter us. . . . We prepared to spend a night upon the dreariest wastes we had ever seen." The Bedouin told Lynch that they had often heard of the cruelty of the Franks, but never supposed they were so cruel as to send one of their own number to a place so desolate. Farther on in his narrative he speaks of being "in the midst of a profound and awful solitude." "Surely," he says, "the curse of God is upon this unhallowed sea."

Lieut. Lynch's discoveries may be summed up in the following facts: The bottom of the Sea consists of two submerged plains, the one at the southern end being thirteen feet below the surface and the one at the northern end thirteen hundred feet below. Running through the northern plain from north to south, and corresponding with the Jordan Valley and the Wady el-Jib at the south end of the Sea, is a depression in the bottom of the Sea which marks the line of the great fault in the earth's crust. It has been generally believed that the earth split open in a distant age, and that the side on the west fell in some five thousand feet, while on the eastern shore the strata of sandstone were depressed but slightly. On the western shore we therefore see the Cretaceous limestone, but the lower Cretaceous Nubian sandstone is far beneath. As this depression did not occur on the eastern shore, we see there the glowing colours of the lower Cretaceous Nubian sandstone, on the top of which, crowning the highest points, is the Cretaceous limestone corresponding with the strata on the western shore, but thousands of feet higher.

Prof. William Libbey, of Princeton, opposes this theory, and denies that the sandstone on the eastern shore is Nubian. He backs up his assertion by facts he discovered a little more than a year ago, and which, I believe, he presented in a lecture before this Society. Prof. Libbey claims that the sandstone on the limestone is a deposit. Erosion laid bare the limestone along the western shore, but on the eastern coast the currents were not strong enough to wear it away. He declares that the western shore could not have fallen five thousand feet, as the dip of the strata

there is not sufficient to indicate it. There was a fault in the earth's surface, and with the rush of water came a great deposit of sediment. This hardened into sandstone, which was finally worn away.

I have never noticed sandstone along the western coast of the Dead Sea, but Prof. Libbey has no doubt that patches of it are to be found. The strongest evidence he advances in support of his theory is discovered at Petra, where he is certain that the sandstone is a deposit upon the limestone. But having never explored the coasts of the Dead Sea, he has only a strong belief that his statements are in accord with the facts.

This new theory has excited much discussion, and will doubtless lead to a more systematic study of the region. Indeed, we need to verify the measurements of Lieut. Lynch. In that heavy body of dead water his sounding-plummets may not have reported correctly; and, besides, changes may have occurred since his day which would materially alter his findings.

There are two points of interest on the western shore that we may well visit. The first is Engedi, which guarded the pass of Ziz up which Chedorlaomer's host went, as recorded in Genesis. From the shore the ascent is made of three hundred feet to a level space, where is found a spring of warm but sweet water. Here are trees, and also grass. Engedi, famous for its grapes and gardens, stood on this spot. Fourteen hundred feet higher is the top of the pass of Ziz. From this summit the view is extensive. On two occasions I have, from this point, seen snow-crowned Mount Hermon, a hundred and sixty miles away, lifting his hoary head far up in the Syrian sky. Looking toward the south, the dark cliffs of Masada stand out above the gleaming waters of the Sea, and far beyond is the southern end, with the Arabah and its treacherous slime-pits. This depression at the south end of the Sea runs through to the Gulf of Akabah, and separates the red mountains of Edom from the Sinai wilderness.

Leaving Engedi, which has always guarded this pass into the Judean country, and going toward the south, we reach Masada in about four hours of hard travelling over the broken rocks and under the burning sun. Masada is an isolated mass of rock which looks much like Gibraltar. It is about two miles back from the shore, and is separated from the Judean range by deep valleys. One must climb seventeen hundred feet to reach its summit—a task both difficult and dangerous. There was, originally, but one narrow winding path called “the serpent” by which access to the top was possible. That path has been worn away by the storms of centuries,

and the explorer must climb as best he can. Reaching the summit, there bursts upon the view a scene of desolation that can scarcely be equalled. To the west are the broken and barren Judean hills. Turning to the east, the sullen waters of the Sea of Death are seen far below. The ruins that crown the summit bring to mind the awful tragedy enacted there shortly after Jerusalem was captured by Titus. The top of this mass of rock is six hundred yards long, and has an average width of two hundred. It was fortified by the Maccabees two hundred years before Christ. Herod the Great further strengthened it, and supplied it with reservoirs and provisions. It was regarded as the strongest fortress in the land. When Jerusalem fell a thousand Jews retreated to this place, thinking that the Romans would not follow them across the wilderness of barren rock. But the place was invested by Flavius Silva, and was at last captured after the Romans had built a great embankment leading to the top. When the Jews saw that all hope was gone, they killed their wives and children, and then certain men were chosen to stab their comrades. Finally, the last man fell upon his own sword and perished. Since that time the place has been abandoned, and has been visited by only a few explorers in modern times. On the eastern shore of Galilee there is a similar fortress, with a history almost identical with that of Masada. Gamala stood guard over that beautiful lake, and when the Romans captured it the Jews threw their wives and children over the cliffs into the valleys below and leaped after them.

Passing on to explore the eastern shore, a narrative of my own expedition down that coast may serve to bring out the facts of interest discovered there.

A small sail-boat owned by the Turkish Government goes from the mouth of the Jordan to a point opposite Kerak, where it lands supplies for the garrison. These trips are few and far between, and no attempt has ever been made to explore the Moab shore with this unsuitable craft. I found two row-boats on the Jordan, and choosing the larger, started out; but a storm knocked the bottom out of it the first night while we were camping at 'Ain Feshka, and we had the pleasure of walking some twelve miles back to Jericho.

The remaining boat was a flat-bottom skiff twelve feet long. It was, doubtless, the smallest that ever navigated those waters. Having secured the services of two men at Jerusalem, I launched out. Our small boat had no room for stowing away a tent, and our stock of provisions was very limited. We did, however, take a six-gallon tin of fresh water, which we regarded with anxious solicitude.



As no one had examined the Moab shore since Lieut. Lynch's time, and as no photographs had ever been taken of that coast, I determined to go close to shore, land frequently, and take many pictures. No one in Jerusalem could give me any idea of the difficulties I might encounter, and I had only Lynch's narrative to guide me. I noticed, first of all, that many beaches spoken of by him, do not now exist. This is especially true between the Zerka Mâ'aîn (Callirrhoe), and the Wâdy Môjib (Arnon). The waters dash up against the perpendicular cliffs, and there are few landing-places where one might seek refuge in case of a storm. That the level of the Sea is changing seems to be evident, and measurements for determining its nature have been taken for some time at a rock near 'Ain Feshkah. But up to the present time nothing of interest has been found.

A few years ago it was possible to ride on a camel from the western shore over to El-Lisan, but that is impossible now. Also, within a few years, it has been possible to walk between Jebel Usdum and the water; but now the explorer must go behind the cliffs, as the Sea comes quite up to their base. Until 1892 there was an island visible at the north end of the Sea, just opposite the hut where travellers rested as they came down from Jericho. Leading out to this island was a causeway submerged a little below the surface. But the island has now disappeared, and I was unable to find trace of it.

In connection with this rise of the sea-level is a strange fact that I noticed at several places along the coast. A short distance east of the point where the Jordan empties into the Sea stand a number of trees of good size, out at least sixty feet from the shore. They were encrusted with salt, and I did not examine them to see whether they were alive or dead. But at the mouth of the Callirrhoe the bushes extend far out into the water, and are so thick that it is impossible to get near the mouth of the river with a boat. I saw the same kind of growth at several points down the coast where streams of fresh water come tumbling down the cliffs. At the mouth of the Arnon trees of fair size grow in ten feet of water.

After I had reported these facts to the Palestine Exploration Fund, I received a note from Dr. George E. Post, of Beirut, Syria, whose book on the flora of Palestine is authority, asking whether the shrubs and trees were yet alive. They certainly were very much alive, and the theory advanced by Dr. Post, that the level of the Sea has been elevated in recent years, overflowing the land on which this vegetation was growing, is probably correct. If there

is still volcanic action going on in this region, as Sir Charles Warren believes, there may have been both a sinking of the land and a rising of the water-level.

The second fact that I reported is with reference to a strong current setting northward along the Moab shore. I observed it all the way down the coast, and it helped me materially on the return journey. Lieut. Lynch speaks of a current running northward which he observed at Engedi. Sir Chas. Wilson commented on my report, and said: "It would be interesting to ascertain whether this constant current is due to subterranean affluents, to unequal barometric pressure, or to wind action." I am sure that it cannot be due to wind action, because it was very strong when the Sea was perfectly quiet. At one time, when there was not a ripple on the Sea, my Arab was obliged to walk fast to keep up with the boat as I drifted northward, while he followed on shore. I have suggested that possibly the force of the Jordan torrent may go down even as far as El-Lisan and be deflected and divided, returning north along the shores. But that even the Jordan has this force seems hardly probable.

The third fact I reported was that at certain points along the coast great quantities of oil flow out from the rocks and spread over considerable portions of the Sea. As we rowed through these places the water fell from the oars in filmy sheets; and while it was quite rough outside, here the water was calm and the waves reduced to almost imperceptible swells. This oil was observed in greatest quantities before I reached the Callirrhoe. On the shore I found large pieces of pure sulphur and lumps of bitumen weighing several pounds. The Arabs speak of great islands of this bitumen, which were thrown up in recent years by earthquake. A stroke of lightning might easily set this mass on fire, and the scenes of the destruction of Sodom be enacted again. Several weeks after this expedition I crossed the Jordan plain from Nebo, and witnessed a thunderstorm on the Dead Sea. Black clouds seemed to come down to the surface of the water, and sheets of lightning were apparently extinguished in the Sea.

On an evening in May, 1899, Mr. Gray Hill, whose house stands on Mount Scopus, at Jerusalem, witnessed a phenomenon which is in direct connection with my discovery of oil flowing out from the Moab shore. Mr. Hill's dragoman called his attention to repeated flashes of light, which apparently came from a hollow in the mountains on the Moab shore and a little above the surface of the Dead Sea. It was not lightning. It did not flash across the sky,

and the night was cloudless. He reported that it flashed up from this hollow and from nowhere else. These flashes continued at rapid intervals of a second or two until 9.30 P.M., when Mr. Hill retired. His dragoman observed them until 2.30 A.M. This phenomenon occurred just about where I saw the oil flowing in greatest quantities. Mr. Hill said that the scene was most impressive, and set one thinking of Sodom and Gomorrah. He believed that the flashes were caused by the ignition of naphtha or petroleum.

The fourth fact that I reported was the following phenomenon: On three successive nights at 7.30 o'clock, when the air was perfectly still and the Sea smooth, a great breaker crashed upon the beach. After a few seconds another came, and then in rapid succession they pounded on the beach until the noise was deafening. This bombardment lasted about an hour, and during all that time not a breath of air stirred. After this the Sea became quiet once more. I was lying asleep on the beach when the first breaker came in on the first night. The noise was so great that I thought a wild beast was crashing through the jungle at the mouth of the Callirrhoe, and I sprang to my feet in alarm. Sir Chas. Wilson has suggested that the phenomenon may be due to a change in atmospheric pressure, resulting in disturbances like the *seiches* on Lake Geneva. Professor Libbey told me that when he was camping at Tafileh, southeast of the Dead Sea, at about the same hour in the evening, the air suddenly commenced to rush down toward the Sea as if it were being sucked into a whirlpool. It almost threw him from his feet and nearly carried the tents away. It is not difficult to see how the vast volumes of hot air rising from the surface of the water suck the cold air down the gorges from the mountains. I found this draft of cold air one evening as I was bathing in the Callirrhoe. It rushed down with such force that I was glad to make my retreat.

I often noticed, while rowing during the day, that a heavy swell would come in toward shore and would soon be followed by others. Not a breath of air would be stirring at the time, but within fifteen minutes the wind was sure to blow. Lieut. Lynch also noticed this fact. I always sought a landing-place as soon as I felt the first swell, and pulled my boat out of danger.

The two most interesting places along the Moab shore are the points where the Callirrhoe and the Arnon enter the Sea. All the way down the coast we saw streams of hot water coming down to the Sea, their borders fringed with rank vegetation. Clinging to the cliffs at different points were palm trees that seemed to have a very precarious foothold. Bold headlands ran out into the Sea,

enclosing bays a mile or two across. But the points upon which I wish to dwell briefly are the two noted above.

The Callirrhoe has always been a famous stream by reason of the medicinal properties of its waters, which are strongly impregnated with sulphur. At the springs, high up among the cliffs, they are from  $110^{\circ}$  to  $140^{\circ}$  Fahr. At the mouth of the stream, where it is twelve feet wide and one or two deep, the water is  $70^{\circ}$ .

From the north shore of the Sea a steamer could easily run over to the Callirrhoe in a couple of hours, and a bathing establishment might be built at this point. But this is not likely to be done, since the Government does not wish improvements of this kind. Last year a neat steam launch was taken down to the Jordan; but it has never been used, as no permit has been given, and none is likely to be.

But the point of greater interest than even the Callirrhoe is the Wady Môjib (Arnon). The chasm of this stream had never been explored—not even by Lieut. Lynch. His boats were too large to pull up over the rapids, and, as the waters fill the chasm beyond, wading or swimming is impossible. Up to this time I had felt that a great mistake was made in venturing out upon this strange and treacherous Sea in a small skiff made of thin pine boards. Now I realized that the boat was just such as I needed to explore the chasm.

The cañon is a hundred feet wide and the stream forty at the point where the Dead Sea is touched. The water is clear, cool, and sweet, and then had a depth of one foot. Fishes of ten inches in length, and in great numbers, were swimming in the shallows. Four hundred and fifty feet up the chasm it turns sharply to the south, and narrows to fifteen feet. Then in a few yards it further narrows to four feet, with the water rushing down furiously. I had stripped myself of clothing, and at this point left the boat and tried to wade against the stream. This I succeeded in doing for a few feet, until I reached a point where the stream again turns toward the east. Looking around the angle, I caught sight of a waterfall, but could get no idea of its height. It must be considerable, however, as its roar can be heard on the beach. Lieut. Lynch calls attention to this sound. It was clearly impossible for me to proceed, and it is evident that to follow the Arnon down from the interior to the Sea is impossible. Professor Libbey made careful measurements of the Arnon valley some fifteen miles back, and found it to be four miles across and three thousand five hundred feet deep.

During my explorations on this coast I was constantly impressed by the fact that if one were shipwrecked between the Callirrhoe and the Arnon it would be very difficult, if not absolutely impossible, to climb to the Moab tableland.

The beauty of the Arnon cliffs can scarcely be exaggerated. The sandstone is a dark, rich red, and curiously carved by the storms of centuries. Indeed, all along this coast the variety of colours in the strata is striking and the hues are gorgeous. They will compare favourably with the magnificence of Petra. Then, as one pushes out upon the Sea and gets a glimpse of the ranges beyond the grandeur of it all is most impressive.

My return to the Jordan brought me face to face with the dangers encountered by previous explorers. A storm came up before we left the Arnon, and raged with great fury for twelve days. I found that the wind generally died down at about one o'clock in the morning, and did not come up again until four. But the waves were always higher than our boat was really able to meet. But provisions were low, we had no tent, and the dark clouds over the Judean hills threatened rain. We took advantage of these hours of comparative calm and ventured out into the darkness. Often the wind unexpectedly increased, and we were obliged to seek a landing-place. This was difficult in the darkness and with the waves coming back in counter-seas from the cliffs. When, at last, almost in despair, we came to a little beach the men jumped overboard in time to save our boat from the rocks, and I threw our baggage ashore, not forgetting to carry carefully our tin of fresh water. On this beach we slept as the storm raged during the day, and at night made as much progress as possible toward the north shore.

Our hands and faces were cracked and sore. The intensely salt water, with oil and sulphur, to say nothing of the many other ingredients contained in it, caused these sores to smart and burn. Our clothing was stiff and greasy, and our shoes were falling apart. We longed for Jericho!

One morning at four the waves threw us upon the beach at the north end of the Sea, but east of the mouth of the Jordan. We crawled behind some bushes to escape the fury of the storm. Soon the rain came down in torrents and the black clouds promised nothing good. The men went out in search of a Bedouin camp, and returned with a camel and half a dozen Arabs. Boat and baggage were strapped on the camel's back, and off we went to the encampment.

The storm continued for two days and nights more, and during that time I had many experiences with these sons of Ishmael.

The facts I have briefly indicated give some idea of the problems yet to be solved and the need of a scientific expedition with full equipment of modern instruments. Commercially the wealth of oil, bitumen, and salt along the shores of the Sea is doubtless great. At only a few points is the odour of sulphuretted

hydrogen too strong for enjoyment; therefore, as a health resort many parts of the coast might be advantageously exploited. To bathe in the warm waters of the Callirrhoe and then swim out upon the surface of the Sea and float lightly on those waters is an experience most pleasant.

In conclusion, I can but repeat what I have said elsewhere. "The Dead Sea is no respecter of persons, and has served all explorers alike. It is as strange and mysterious as ever. Mr. Gray Hill warns against all attempts to venture out upon it unless one has a staunch vessel. I repeat the warning. The Sea may appear fair and inviting to the tourist who lingers but a few minutes on the north shore; but, beware!"

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## THE DEVELOPMENT OF CUT-OFF MEANDERS.

BY

W. S. TOWER.

*Purpose.*—The following article represents a part of a year's work in physiography under the direction of Professor W. M. Davis, to whom the author owes much for helpful suggestions and criticism.

The object of the article is to describe and explain, as completely as possible, the essential features of successive stages in the development of a cut-off meander. In the course of the work both inductive and deductive methods have been found useful.

The order of procedure has been, first, to deduce the normal order of river changes in an ideal case. Then these expected changes have been confronted with the facts of observation. The two methods of investigation have been necessarily more or less concomitant. A systematic study of the Preliminary Maps of the Mississippi River and the Annual Reports of the Mississippi River Commission from 1880 to 1902 has been the main source of observed facts.

*Definitions.*—The definition of certain terms is made necessary by the general lack of satisfactory definitions both in text-books and in books of reference. Hence, to insure a clear understanding of their subsequent use, they are here given at the outset.

*Meandering*, a characteristic habit of mature rivers, may be defined as winding freely on a broad flood-plain, in rather regular river-developed curves. Under special conditions meanders may occur on plains not essentially river-made—that is, not flood-plains or incised below their original level.

*A meander*, a characteristic feature of a river that has reached maturity, is one of a series of regular curves, alternating right and